Cartography M.Sc.

Visualization of Landscape Changes in a 3D Environment using the Storytelling Approach - the Example of the City of Pristina

Festina Sadiku

Outline

- Introduction and motivation
- Research objective
- Methodology
- Results
- Conclusion and outlook

Introduction and motivation

Visualizing landscape changes encourage users in understanding and comparison of the **past** with the **present**[1].

Objects with more than **three dimensions** can be used to model geographical phenomena[2].

Maps are good to represent a geographic space but **text** have a better benefit than maps for **telling a story** [3].

1. **Popelka, S., & Brychtová, A.** (2011). Olomouc—Possibilities of Geovisualization of the Historical City. *Geoinformatics FCE CTU*, *6*, 267–274. https://doi.org/10.14311/gi.6.33

2. **Arroyo Ohori, K., Ledoux, H., & Stoter, J.** (2017). Visualizing higher-dimensional space-time and space-scale objects as projections to $\mathbb{R}$ 3. *PeerJ Computer Science*, *3*, e123. https://doi.org/10.7717/peerj-cs.123

3. **Mocnik, F.-B., & Fairbairn, D.** (2018). Maps Telling Stories? *The Cartographic Journal*, *55*(1), 36–57. https://doi.org/10.1080/00087041.2017.1304498

Thesis motivation

No map, interactive animation, visualization or 3D model is existing for the City of Pristina.

Thesis aim

Drafting a 3D model with a lightshow on top of it to visualize and tell the story of the landscape change of the City of Pristina.

Research objective

The main objective of this thesis is to investigate how textual descriptions about landscape changes can be transferred and attractively communicated in a 3D model using the storytelling method.

RO1 Visualization of textual descriptions using storytelling method.

RO2 Evaluation of the effectiveness of the visualization (3D model and projection).

Research questions

RO1	**Visualization of textual descriptions using storytelling method.**
RQ1.1	How are the landscapes changes revealed in textual descriptions?
RQ1.2	How can the textual descriptions transferred into a spatial model?
RQ1.3	Which further datasets are needed for the creation of a 3D model and what further storytelling elements are beneficial for projection in order to visualize landscape?

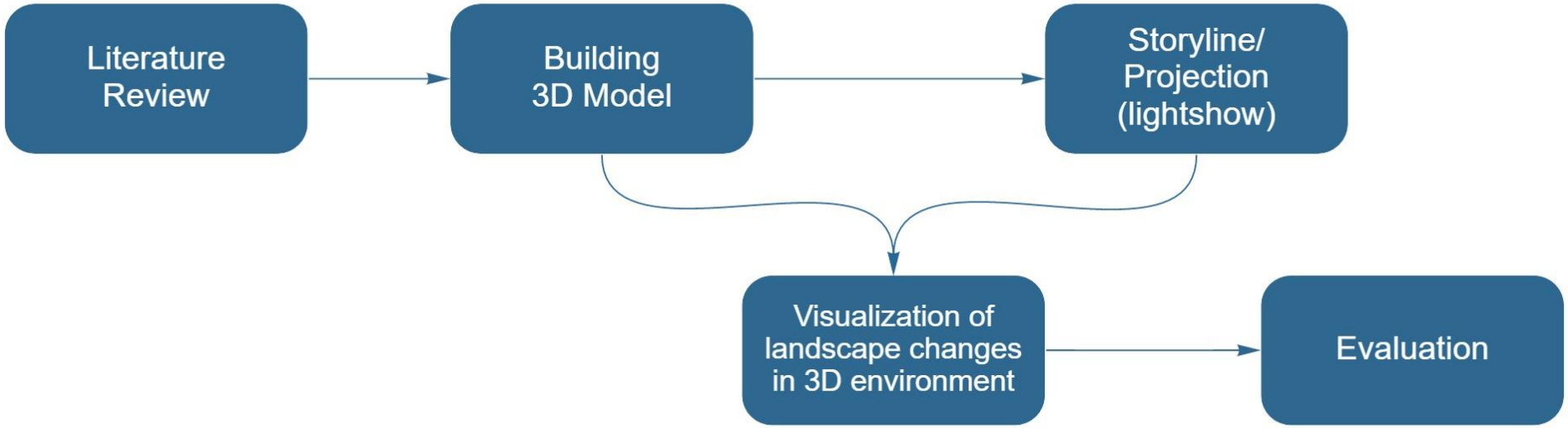
Research questions

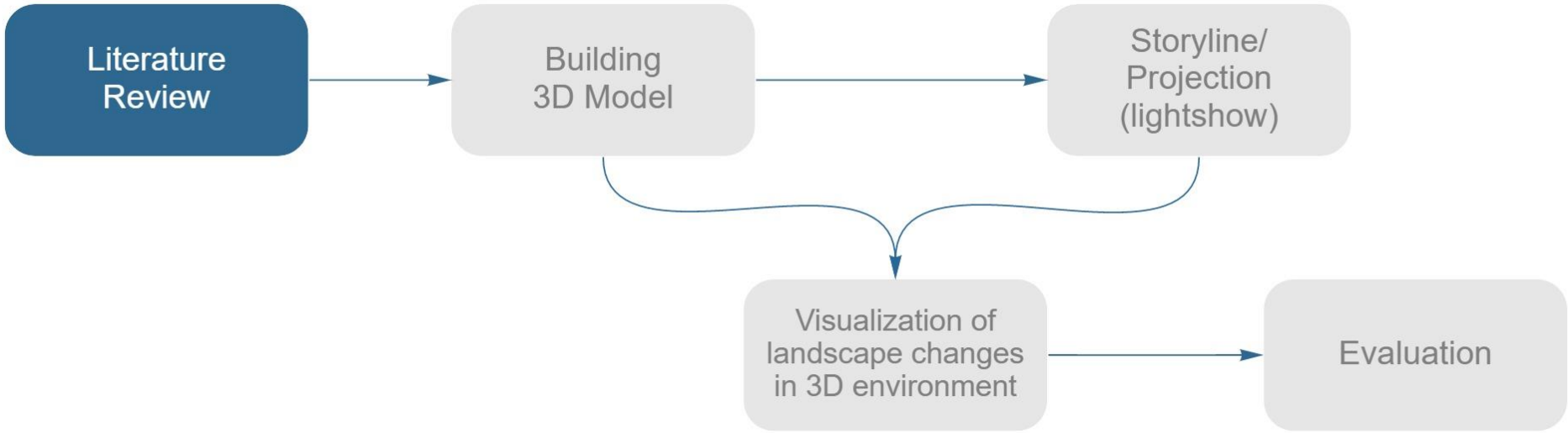
RO2 **Evaluation of the effectiveness of the visualization (3D model and projection).**

RQ2.1 Is a projection (lightshow) on top of a 3D model an attractive opportunity to visualize landscape changes?

RQ2.2 Can the user see the changes through time in this visualization?

Methodology


Literature Review
Building 3D Model
Storyline/ Projection (lightshow)
Visualization of landscape changes in 3D environment
Evaluation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Evaluation

Visualization in 2D

[4]

Figure 1. Maradona marsh.

Methods to visualize the spatial-temporal change in 2D:

- 2D map(s)
- 2D satellite image(s)
- Animation
- Overlay
- Highlighting

4. https://www.skyladderdrones.com/projects/2d-mapping_**madrona_marsh**/

Visualization in 3D

[5]

Figure 2. City of Olumuc.

Methods to visualize the spatial-temporal change in 3D:

- 3D map(s)
- 3D (Photorealistic) model(s)
- Space-time cube(s)
- Overlay

5. Popelka, S., & Brychtová, A. (2011). Olomouc—Possibilities of Geovisualization of the Historical City. *Geoinformatics FCE CTU*, *6*, 267–274. https://doi.org/10.14311/gi.6.33

Visualization in 4D

Figure 3. Stolen heart video map. [6]

Methods to visualize the spatial-temporal change in 4D:

- 3D model(s)
- Animation
- Satellite image(s)
- Sound (voice)
- Time series

6. https://segd.org/**stolen-heart-video-map**

Visualizations in virtual, mixed and augmented reality

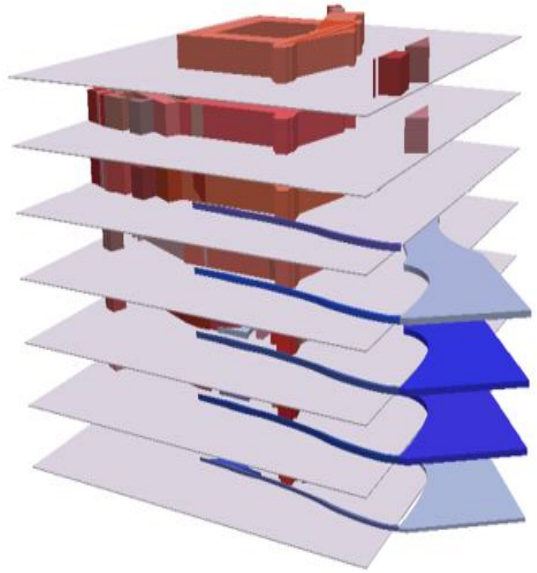
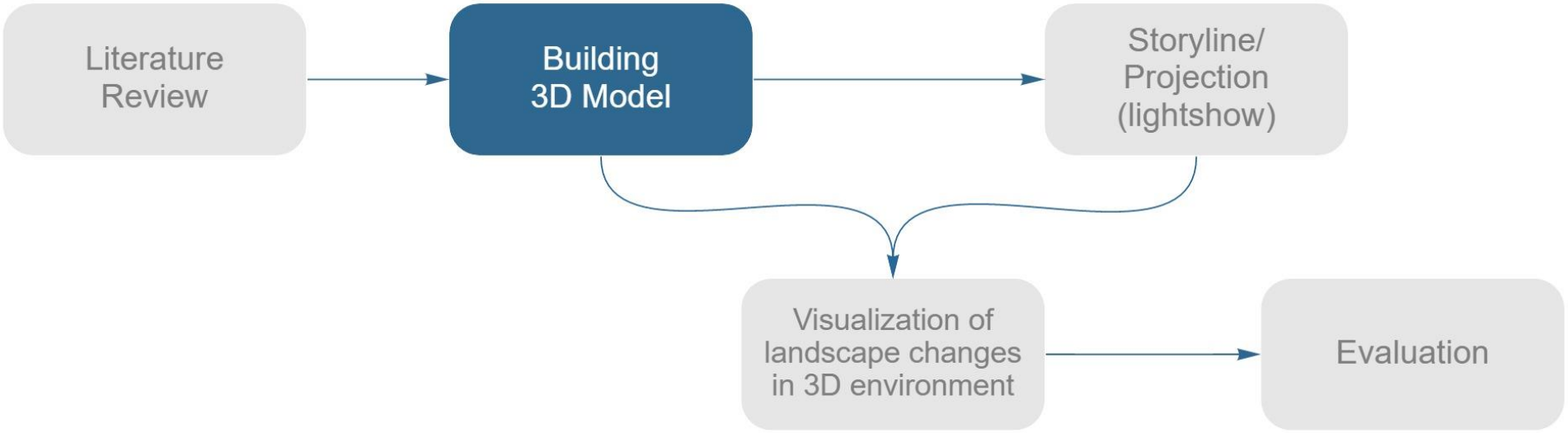


Figure 4. Royal Castle of Warsaw. [7]

Methods to visualize the
spatial-temporal change in VR, MR and AR:

- Space-time cube
- 3D model(s)
- Photorealistic image(s)

7. Bogucka, E., & Jahnke, M. (2018). Feasibility of the Space–Time Cube in Temporal Cultural Landscape Visualization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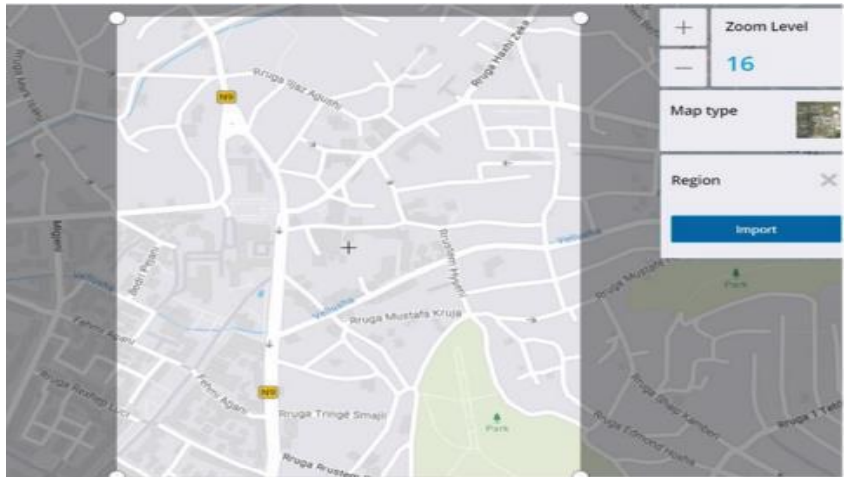
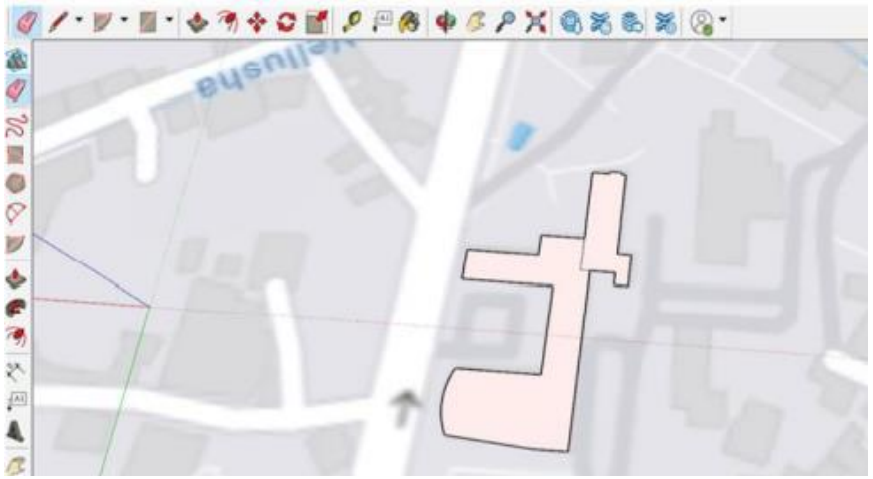
Modelling the cultural historical objects

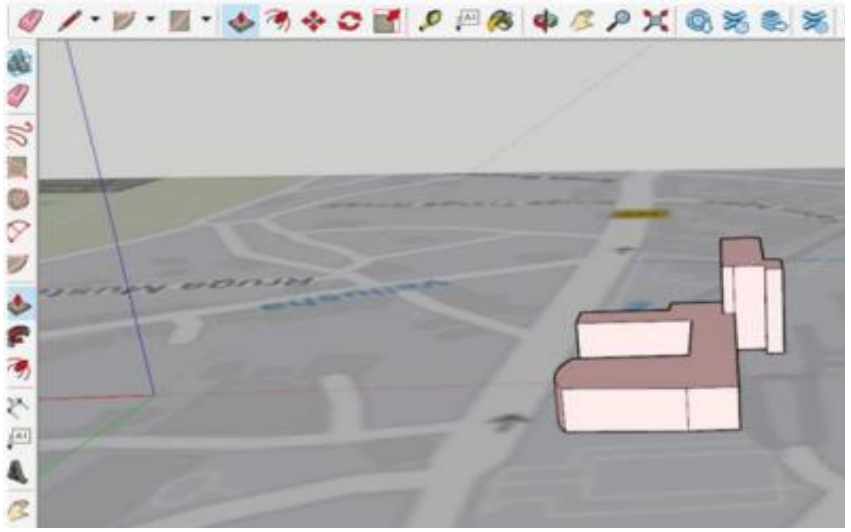
Geolocation



Vectorization



3D model



Design

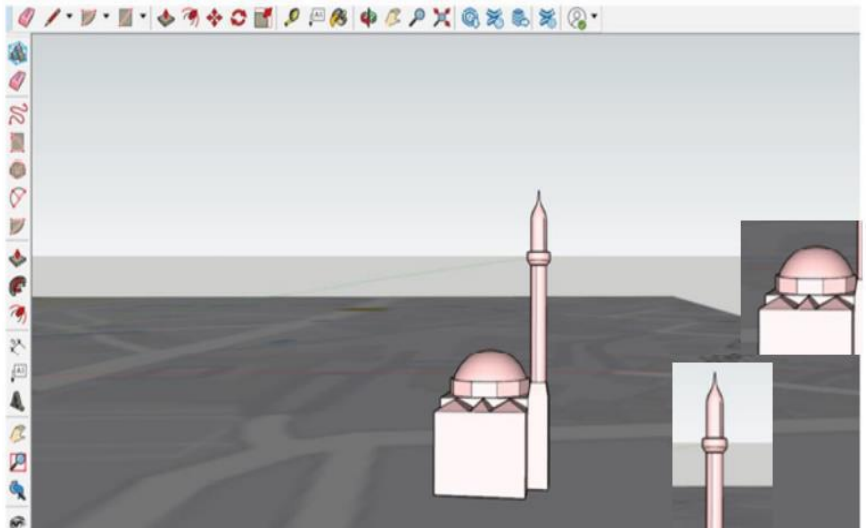
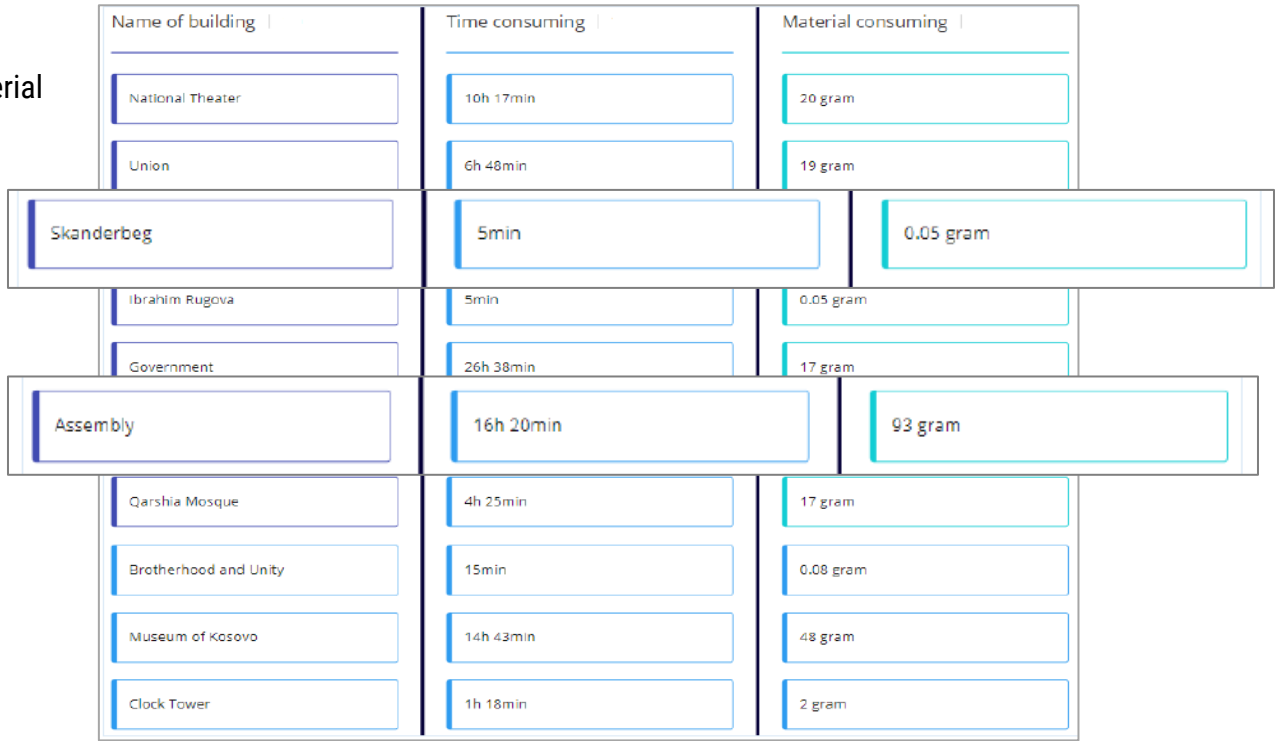


Figure 5. Steps on modeling cultural objects.

Dimension of reality, map and Cura, scale 1:500

		Dimension of reality (m)			Scale 1:500			Dimension on map (cm)			Dimension on Cura Software (mm)		
	Objects	X	Y	Z	(X/500)*100	(Y/500)*100	(Z/500)*100	X	Y	Z	X	Y	Z
1	National Theater	31	78	30	(31/500)*100	(78/500)*100	(30/500)*100	6.2	15.6	6	62	156	60
2	**Union**	**30**	**28**	**19**	**(30/500)*100**	**(28/500)*100**	**(19/500)*100**	**6**	**5.6**	**3.8**	**60**	**56**	**38**
3	Skanderbeg	4	2	10	(4/500)*100	(2/500)*100	(10/500)*100	0.8	0.4	2	8	4	20
4	Ibrahim Rugova	4	2	10	(4/500)*100	(2/500)*100	(10/500)*100	0.8	0.4	2	8	4	20
5	Government	40	70	71	(40/500)*100	(70/500)*100	(71/500)*100	8	14	14.2	80	140	142
6	**Assembly**	**71**	**132**	**25**	**(71/500)*100**	**(132/500)*100**	**(25/500)*100**	**14.2**	**26.4**	**5**	**142**	**264**	**50**
7	Qarshise Mosque	21	20	45	(21/500)*100	(20/500)*100	(45/500)*100	4.2	4	9	42	40	90
8	Brotherhood and Unity	2.5	3	17	(2.5/500)*100	(3.5/500)*100	(17.5/500)*100	0.5	0.7	3.5	5	7	35
9	Museum of Kosovo	39	25	29	(39/500)*100	(25/500)*100	(29/500)*100	7.8	5	5.8	78	50	58
10	Clock Tower	5	5	26	(5/500)*100	(5/500)*100	(26/500)*100	1	1	5.2	10	10	52

Objects with the required time and material



Printing the 3D model

Ibrahim Rugova statue

Skanderbeg statue

Brotherhood & Unity

Clock Tower

Government

Museum of Kosovo

National Theater

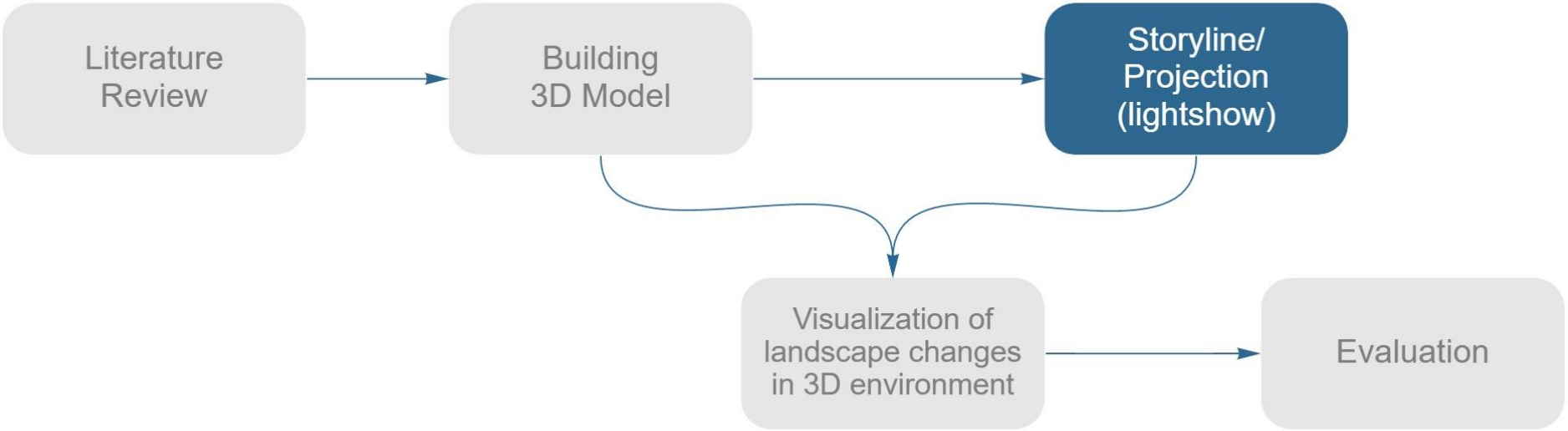
Union

Assembly

Qarshia Mosque

CNC engraving road modeling

Figure 6. Engraving road model.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Textual Data Collection

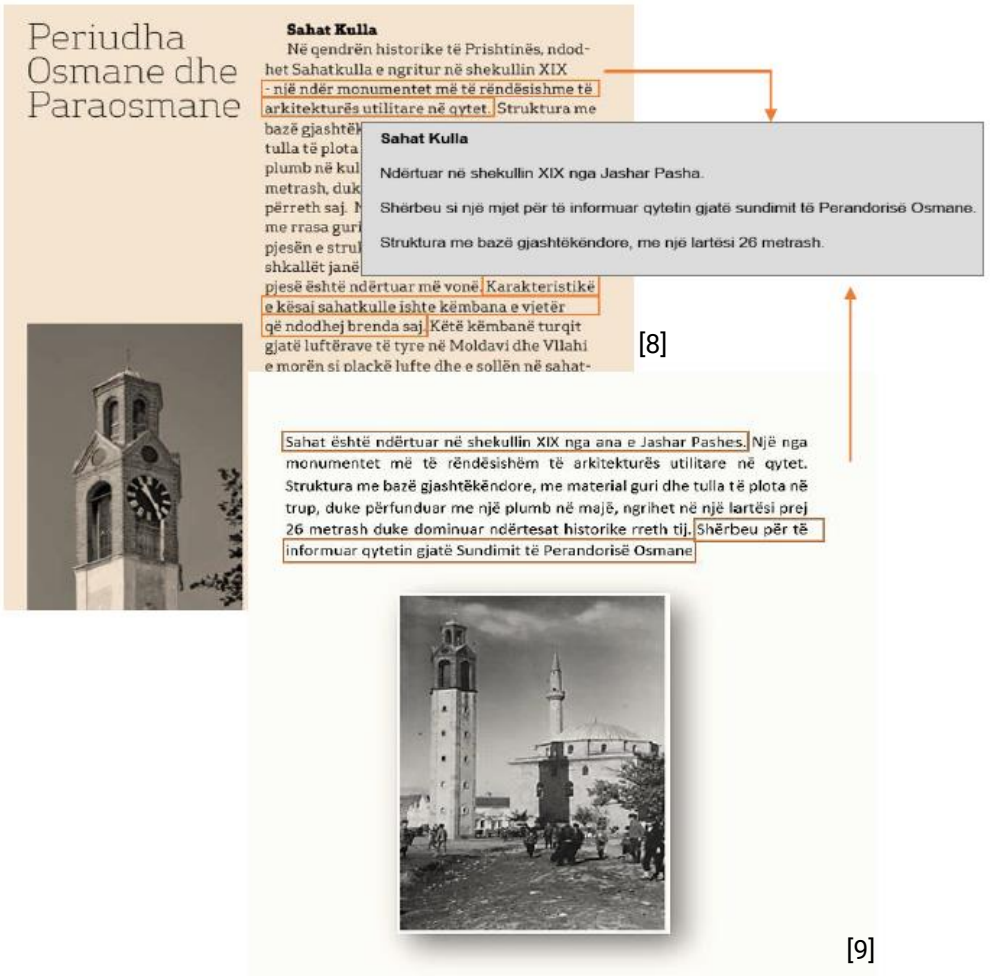

Figure 7. Collection and categorization of textual data

1. Overview of landscape change in general
2. Detailed research to all 10 buildings
3. Buildings following the same storyline:
   - Year of construction
   - Year for remodeling
   - The main characteristics of the monuments Architect or designer
   - How it is used the monuments
4. Highlighting method

8. Gashi, S. (2020) Pristina a unique monograph of the past of the city, history, tradition, culture and its people.
9. Sylejmani, Sh. (2010). Prishtina Ime.

Preparation of Additional Datasets

Data	Author	Year
Cadatral Plan	Kosovo Cadastral Agency	1894
Orthophoto	Kosovo Cadastral Agency	2001
Orthophoto	Kosovo Cadastral Agency	2004
Orthophoto	Kosovo Cadastral Agency	2009
Orthophoto	Kosovo Cadastral Agency	2012
Orthophoto	Kosovo Cadastral Agency	2018
Border of Prishtina	Kosovo Cadastral Agency	2018
Textual Data	Sanije Gashi	2020
Textual Data	Sherafedin Sylejmani	2010
Textual Data	Municipality of Prishtina	2018
Textual Data	Fjollë Çaka	2019
Archival Images	Sanije Gashi	2020
Archival Images	Sherafedin Sylejmani	2010

- Cadastral Plan
- Orthophotos
- Borders of Pristina
- Archival Images
- Textual Data
- Audio

Creating the Projection

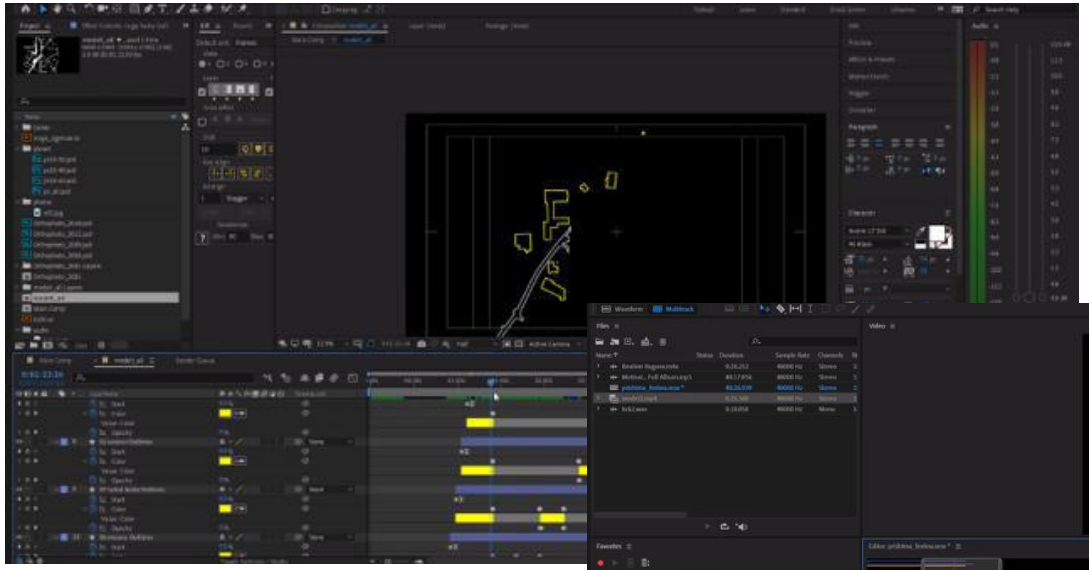

Figure 8. Elaboration of the first phase: Introduction.

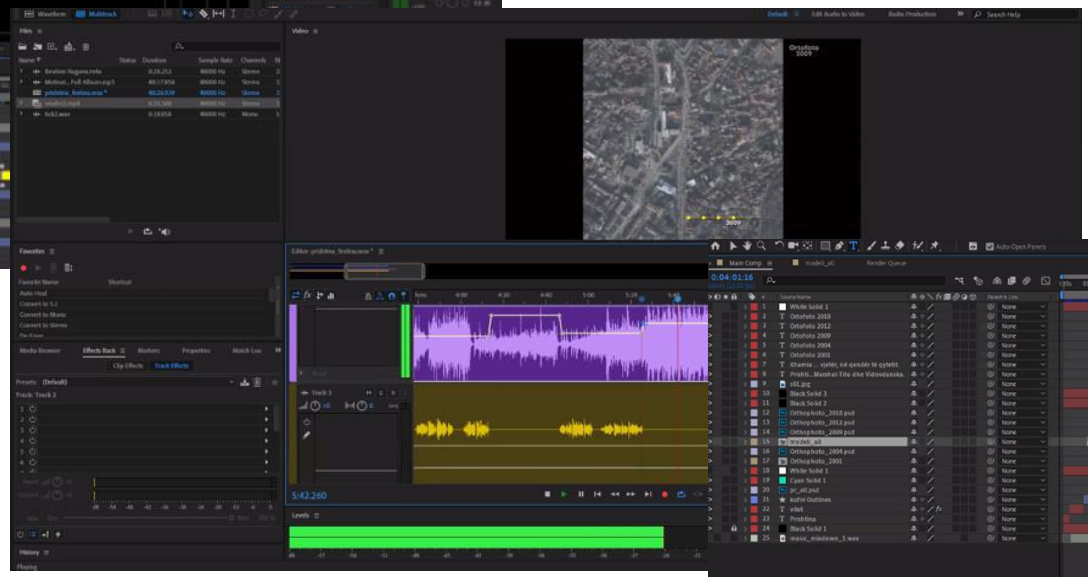

Figure 9. Elaboration of the third phase: evolving city by orthophoto.

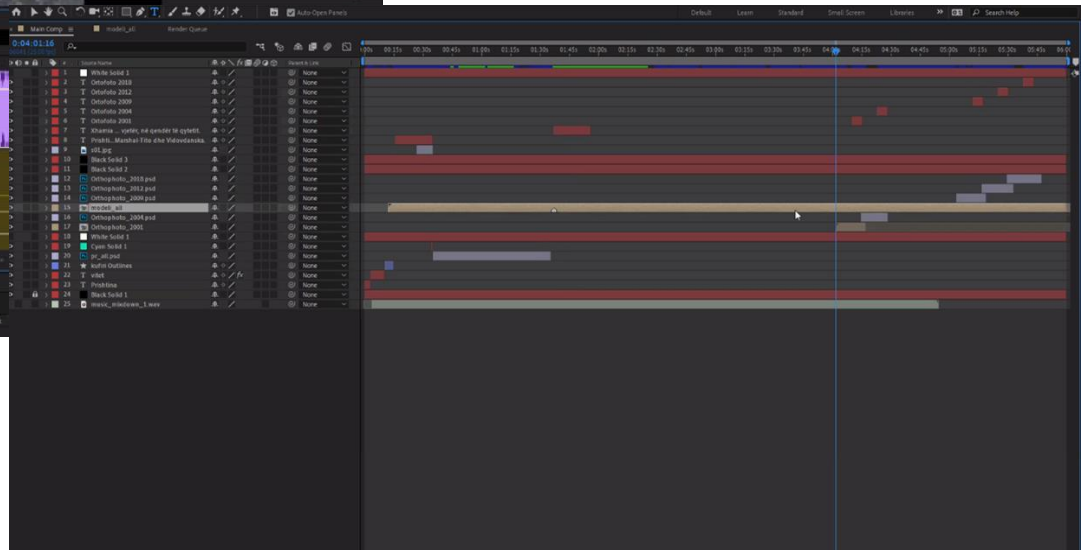

Figure 10. The final stage of projection.

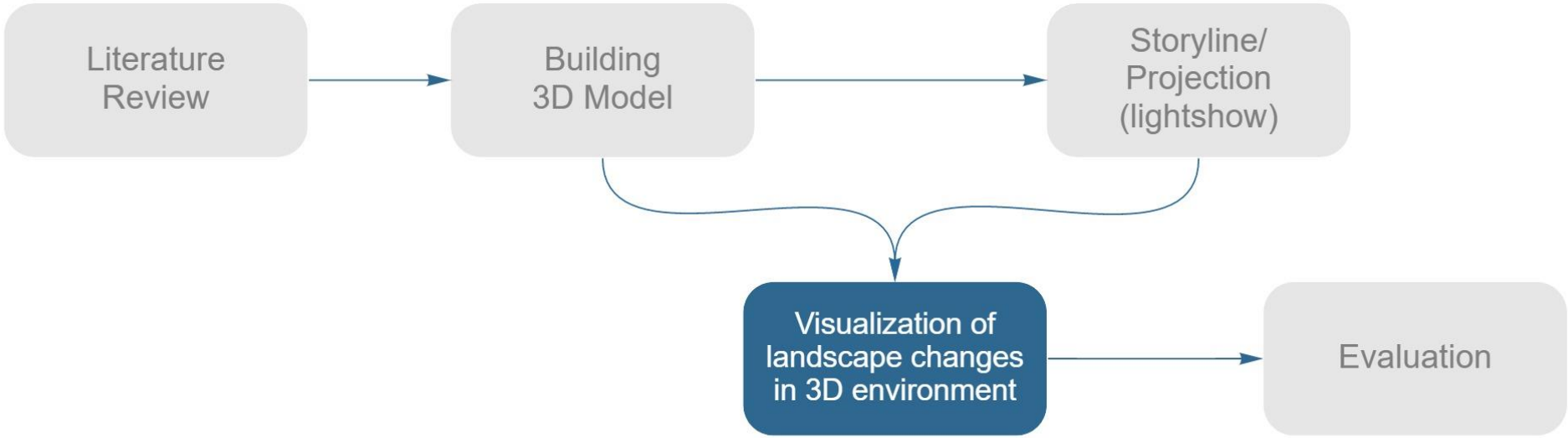
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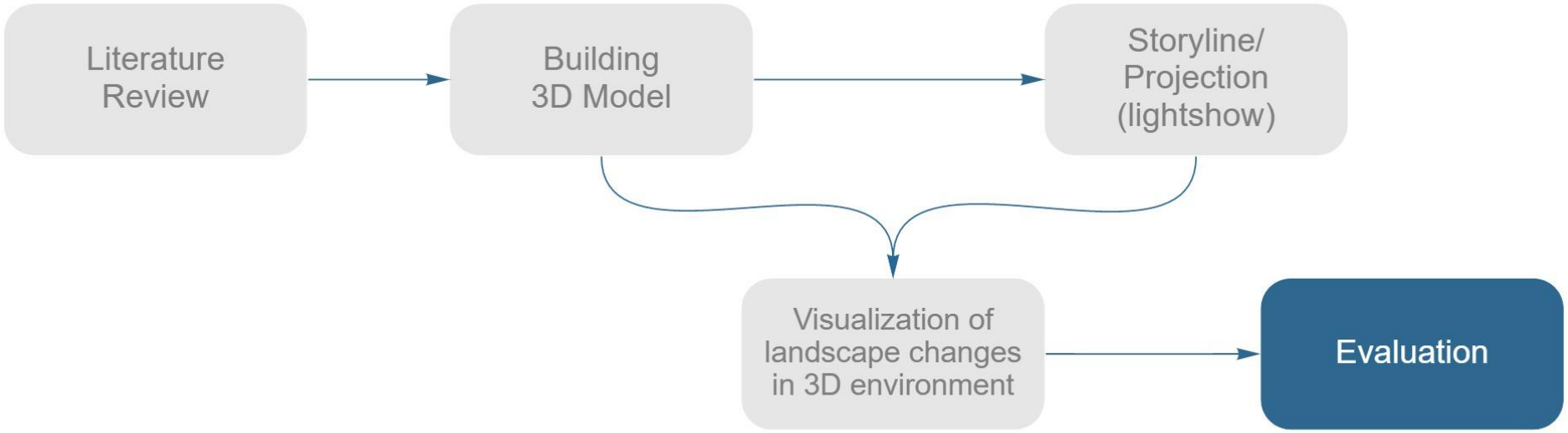
Figure 11. Prototype with sequences taken from animation.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Results

The exhibition setup

Figure 12. Exhibition setup.

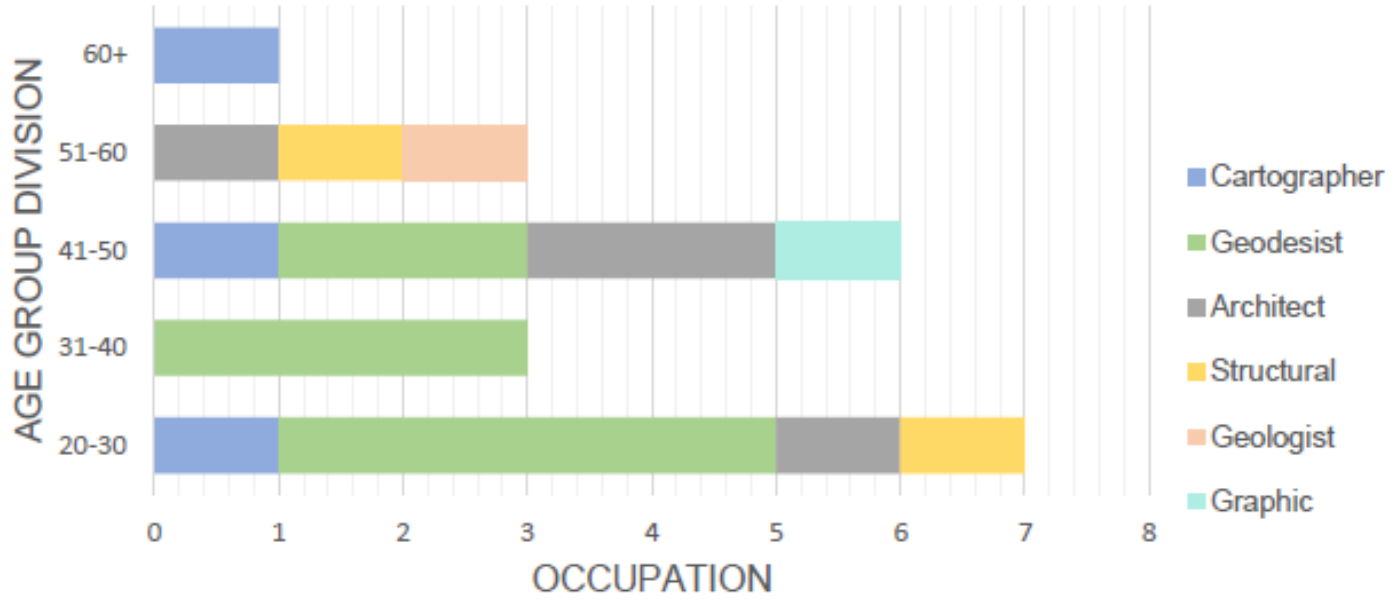
Amphitheater of the University of Pristina

1st - 3rd September 2021

Equipment available:

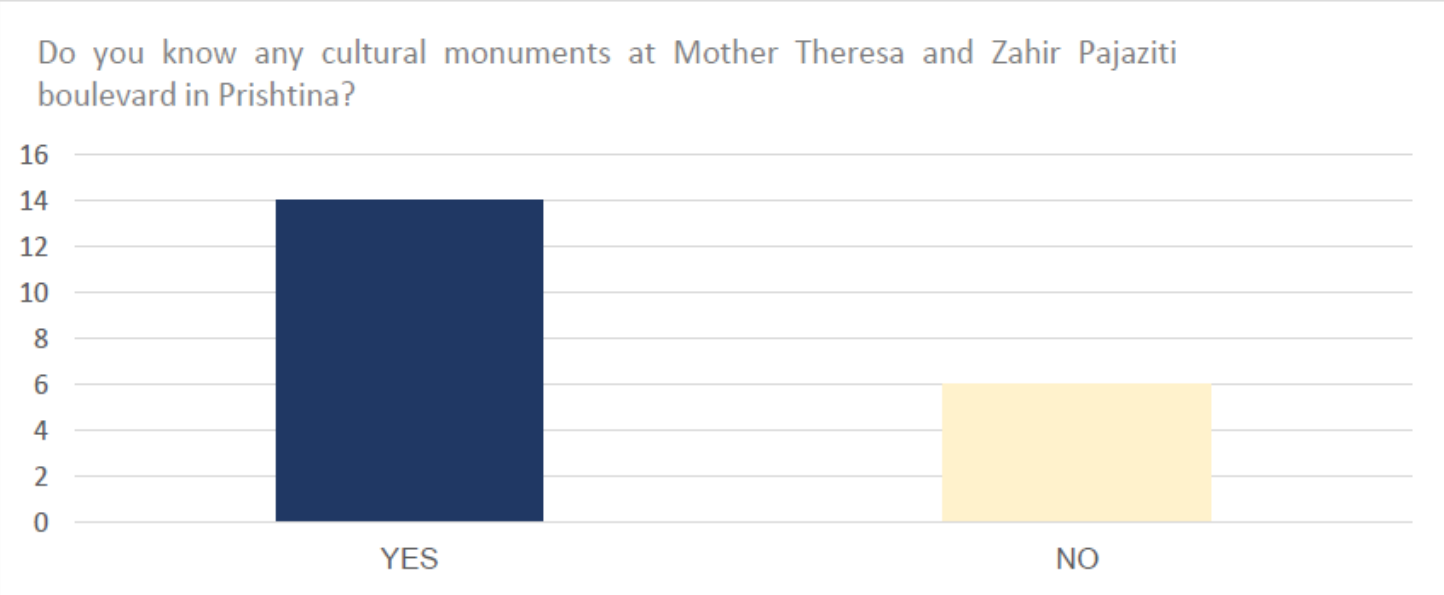
- 3D models of the buildings
- Wooden base plate
- Video projectors ACER X1323WH to project the lightshow
- Anker Sound Core 2 Portable for the sound (voice and music)

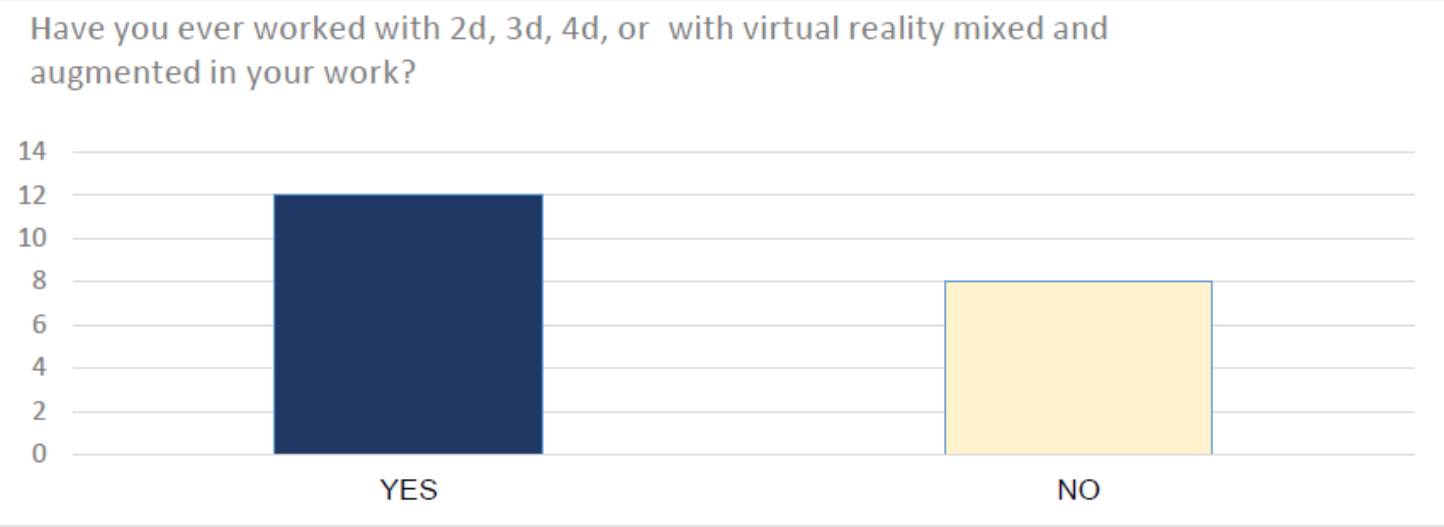
User group



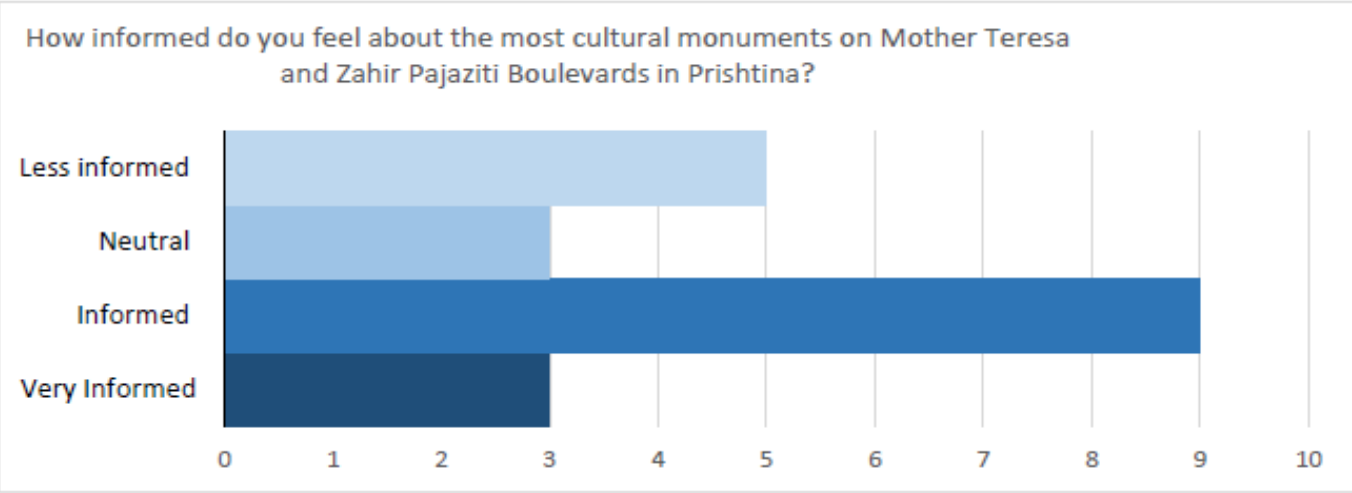
- 20 valid cases
- Different professional backgrounds
- Different prior knowledge

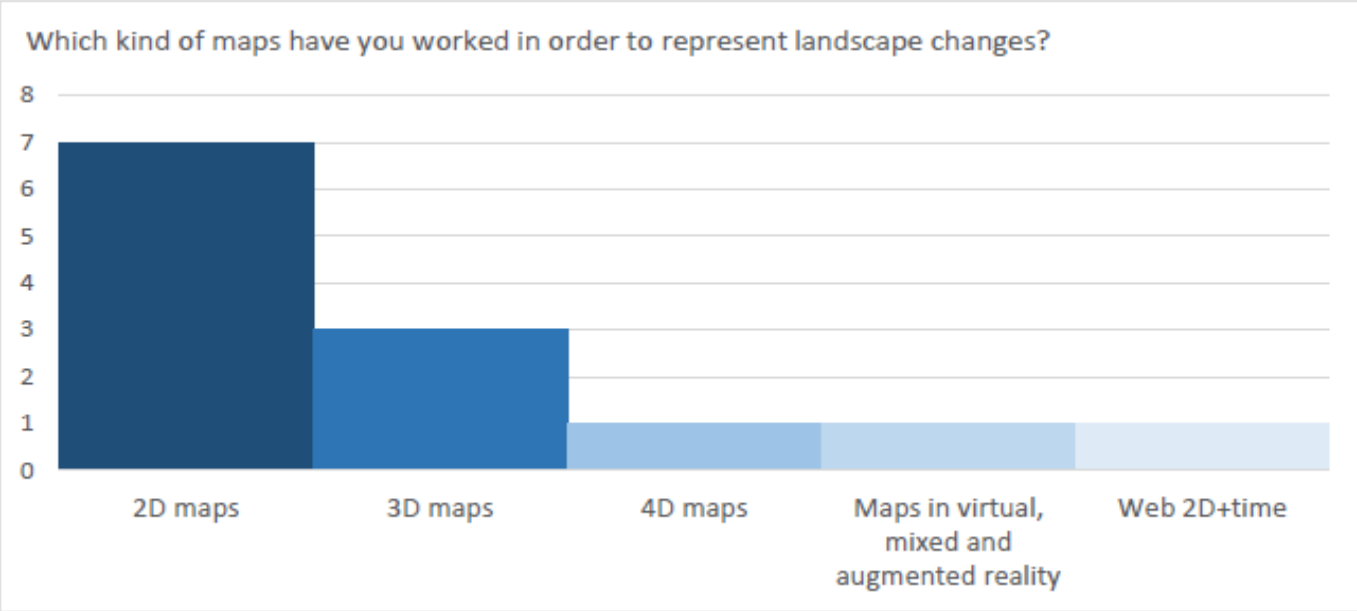
User´s prior knowledge (1)



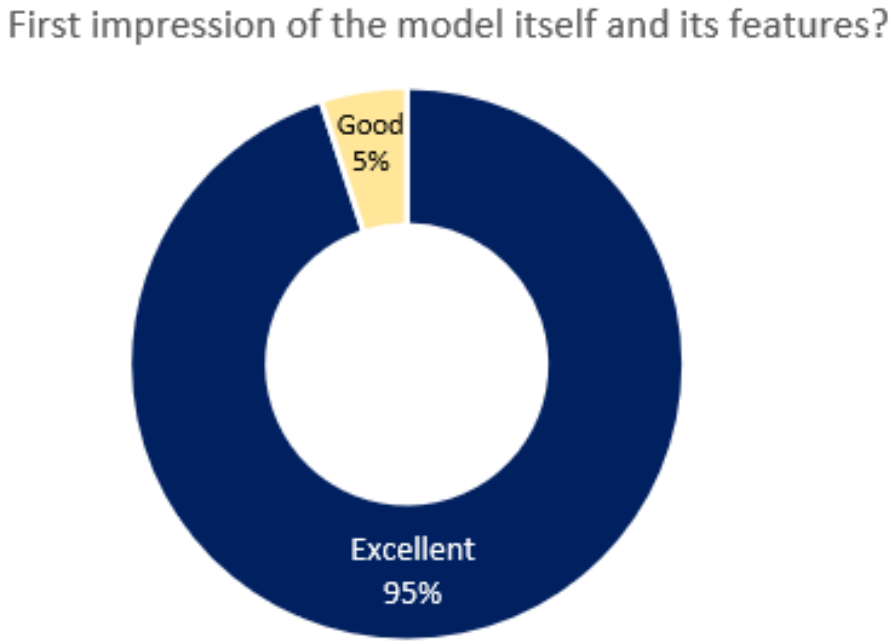


User´s prior knowledge (2)



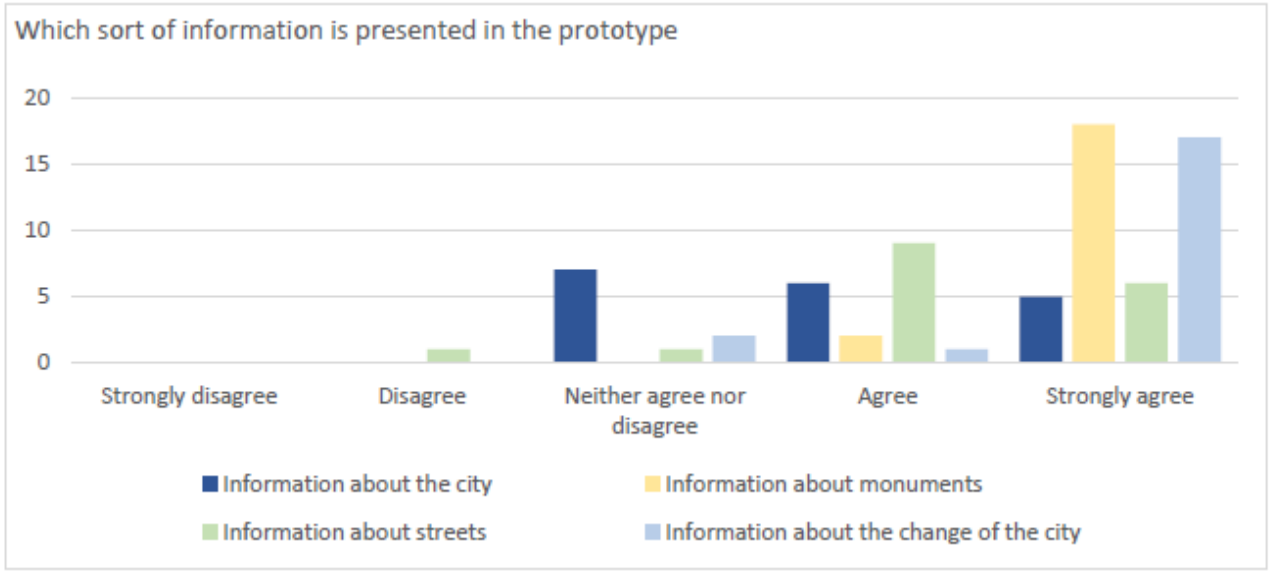


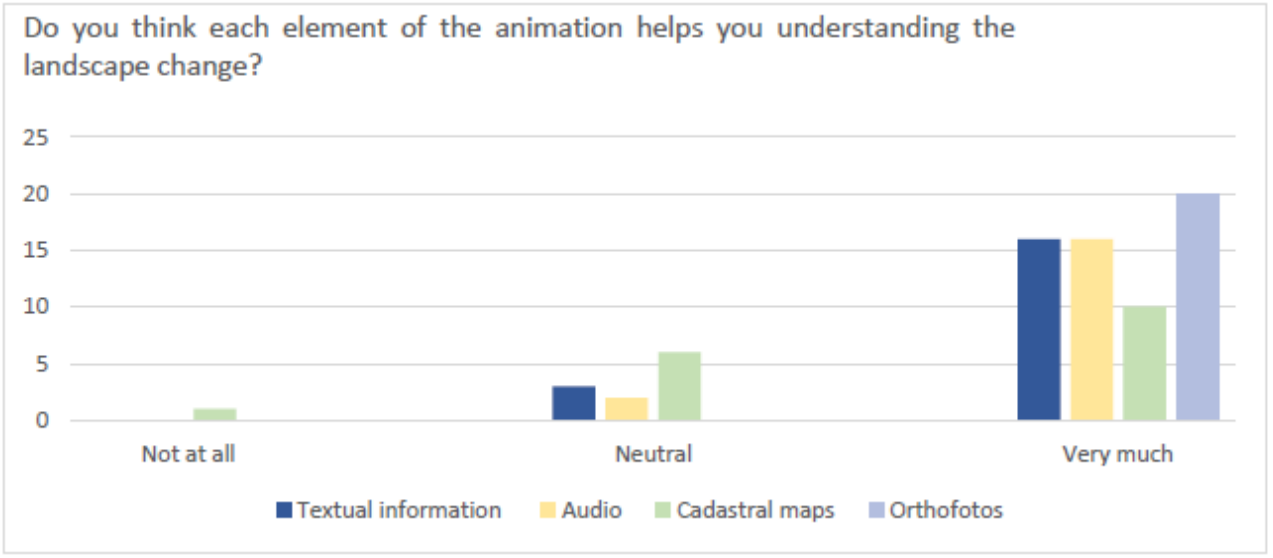
User´s impression



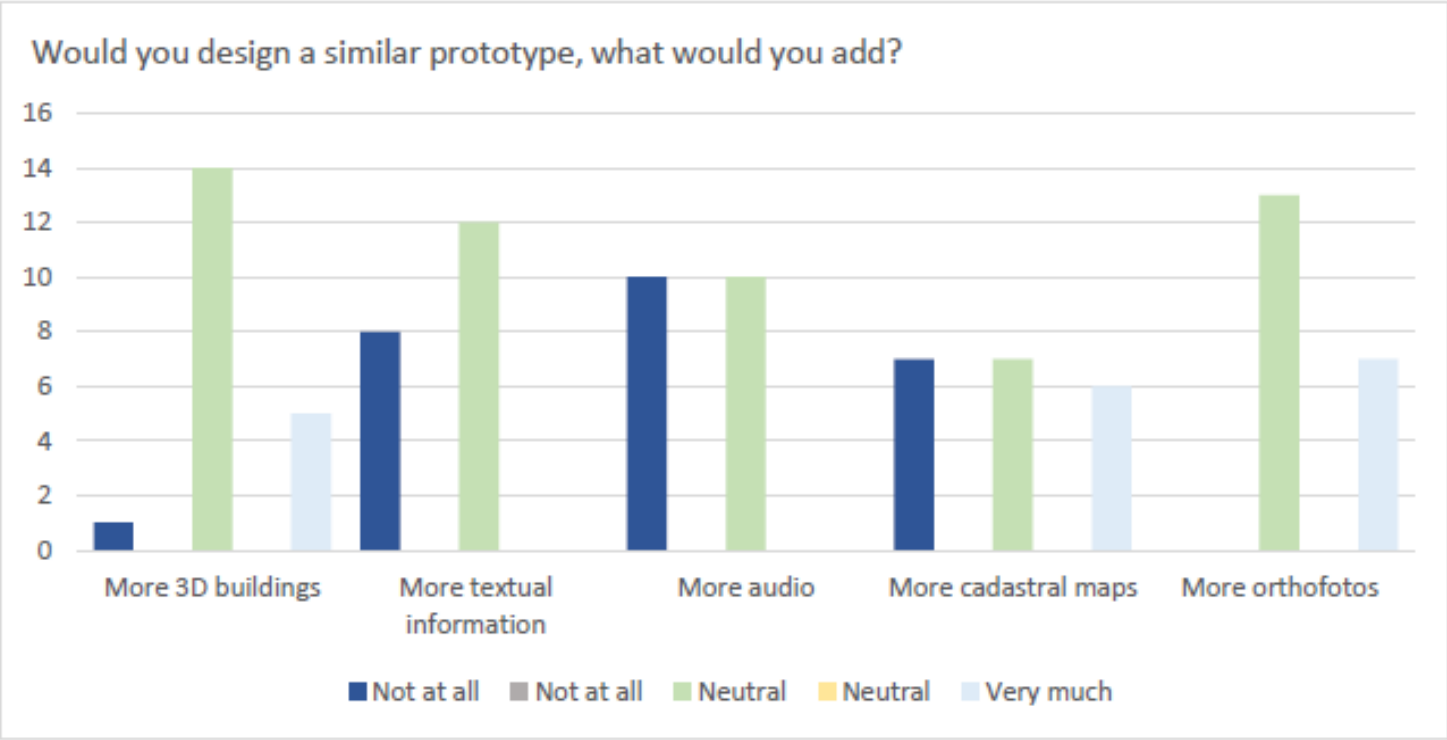
“It is very interesting and very accurate. The reason for the reply "good" is since I am an architect by profession and I have traveled a lot outside Kosovo, I am aware of 3D models that represent the change of a place or a storytelling with time-series for a certain event. The advantage of the models I have seen is that they have used a larger space and have displayed more objects, more animation."

User´s responses

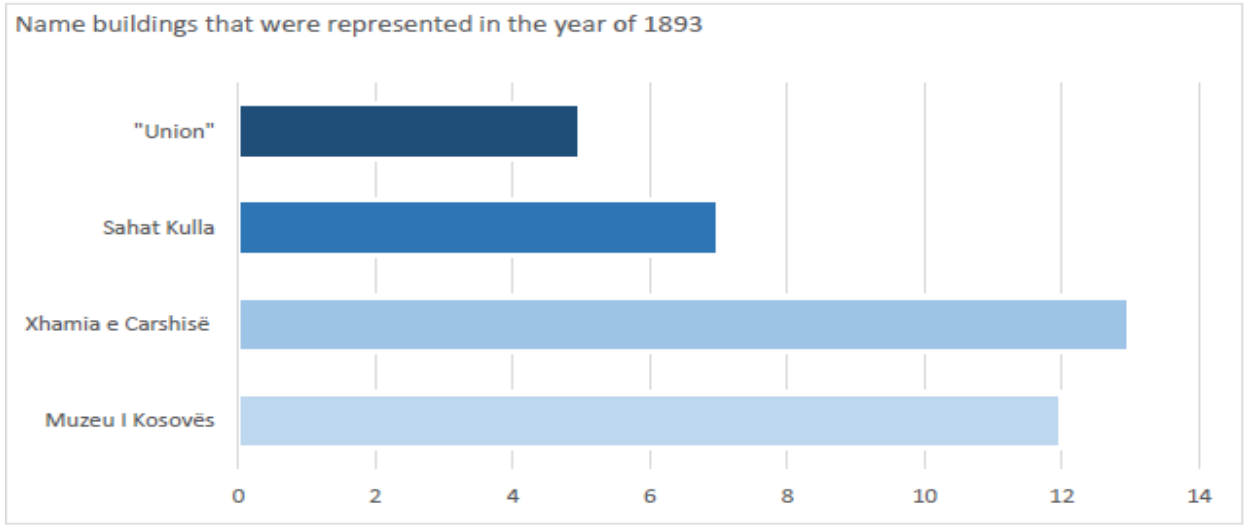


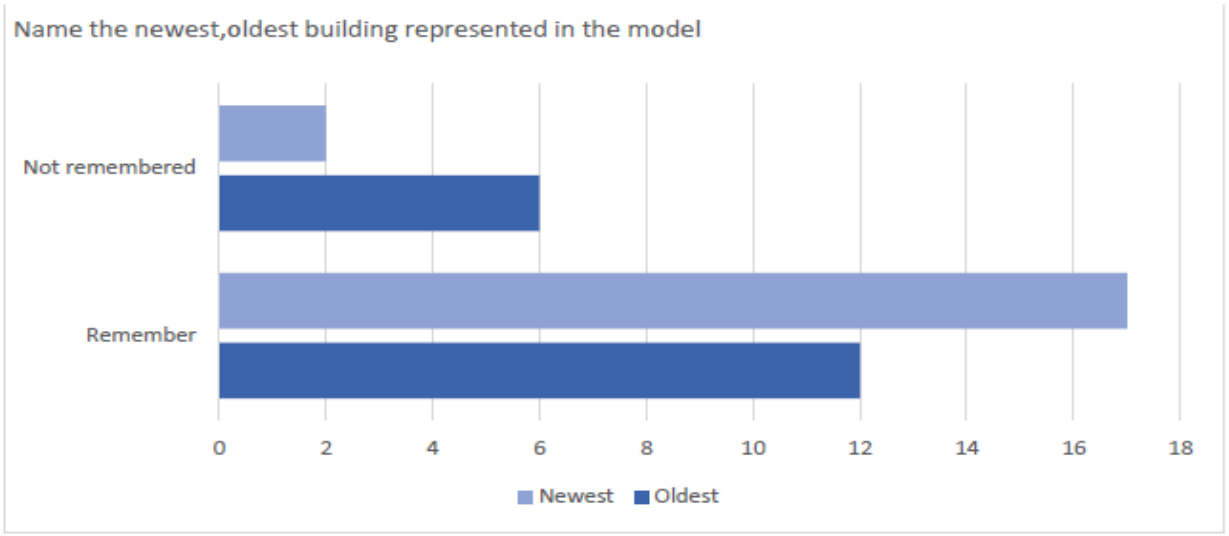


User´s suggestions

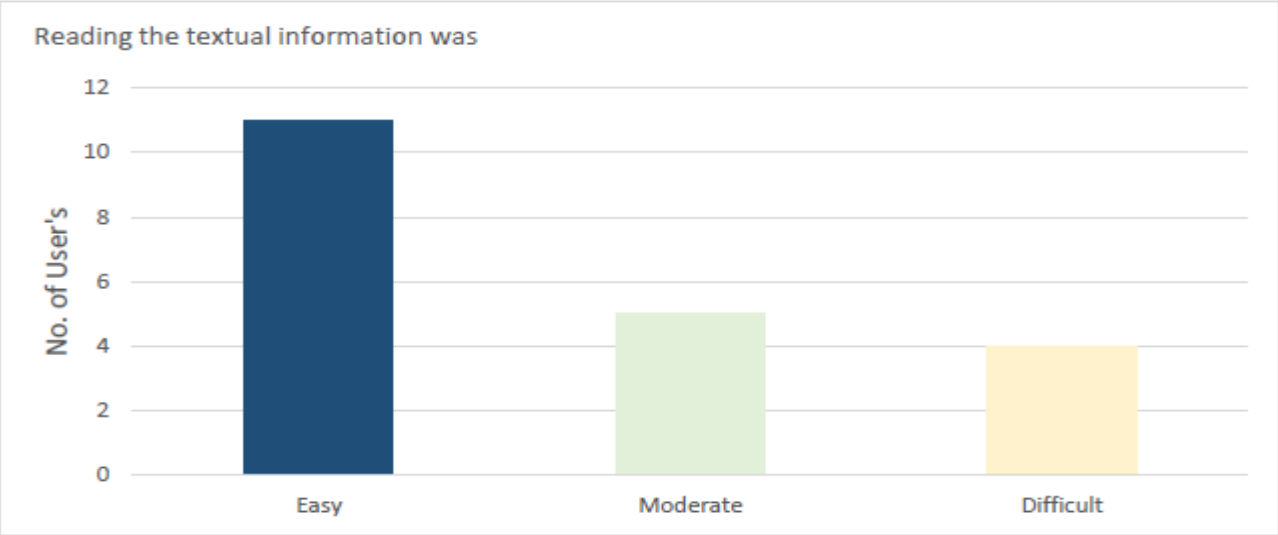


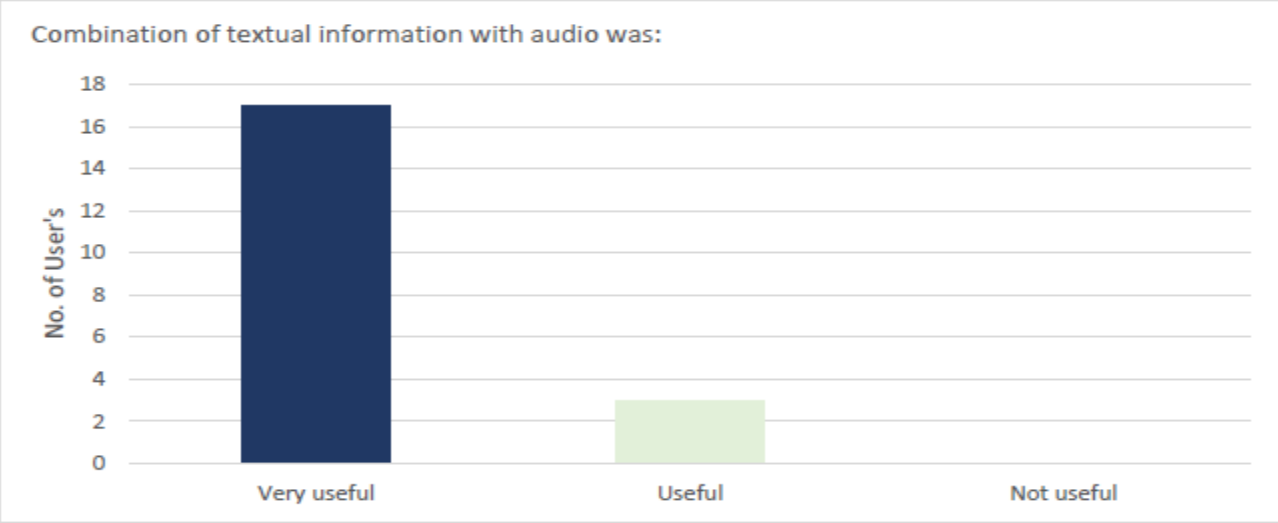
User´s memorization



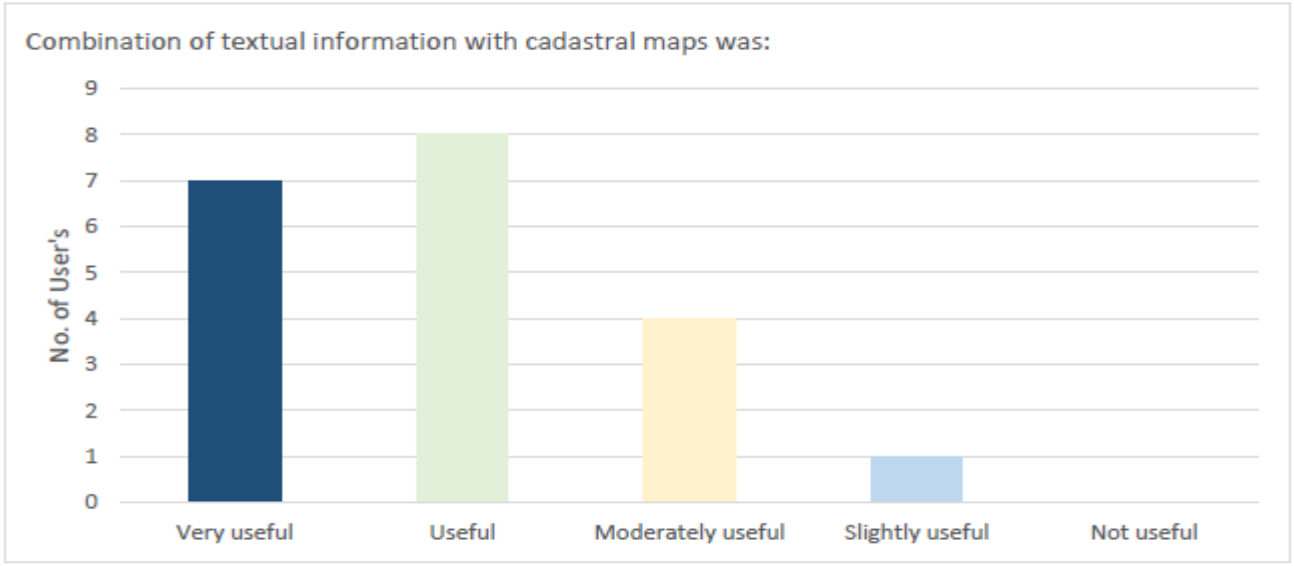


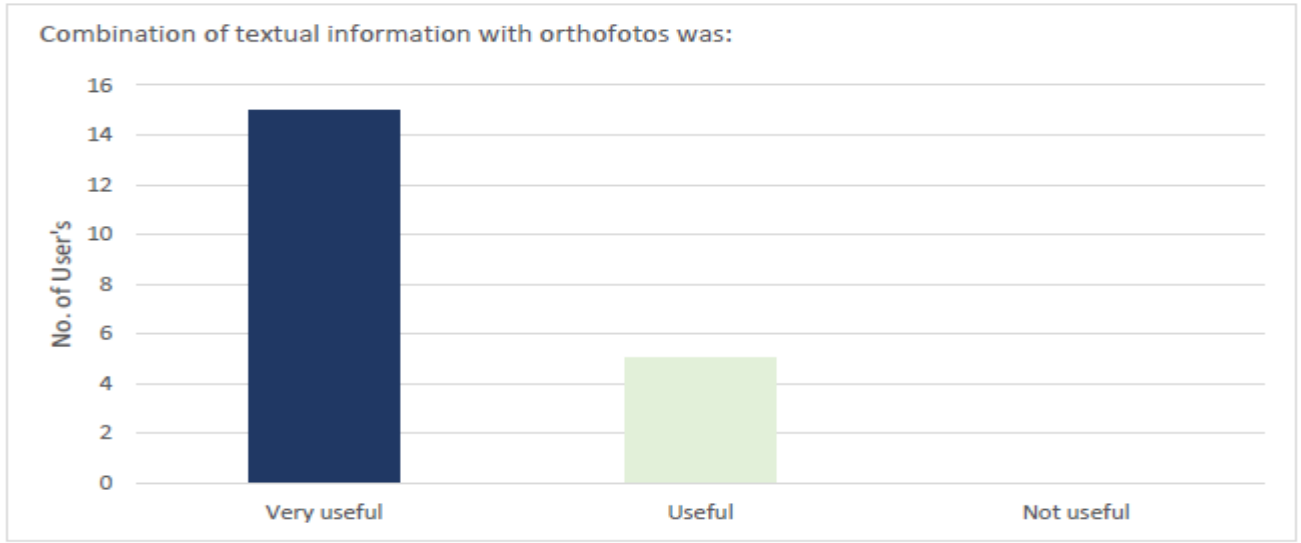
User´s difficulty level (1)





User´s difficulty level (2)





Conclusion and outlook

RO1 Visualization of textual descriptions using storytelling method.

Multimedia is the **key element** of interactive storytelling used **to represent** and transfer **textual descriptions** in a **spatial model.**

The text is one element in the **narrative** approach and mainly **supports** the **visualization** by providing additional information on the most important **landscape changes** with the categorization of features.

Data sets needed for visualizing landscape changes are **text, audio, cadastral maps, and orthophotos, archival images.**

RO2 Evaluation of the effectiveness of the visualization (3D model and projection).

Majority of **users found** the combination of **textual descriptions** an **attractive** solution for describing the **landscape changes.**

The **time series elements** helped users see the **visualization** of changes through the time approach in **storytelling.**

Users stated that the **model** looked **accurate**, **attractive**, and the combination of materials was **pleasing**.

The methods and techniques used are a **recommendation** for similar cities that have overcome a similar **landscape change** but not for cities or areas that have a **different type** of **landscape change**.

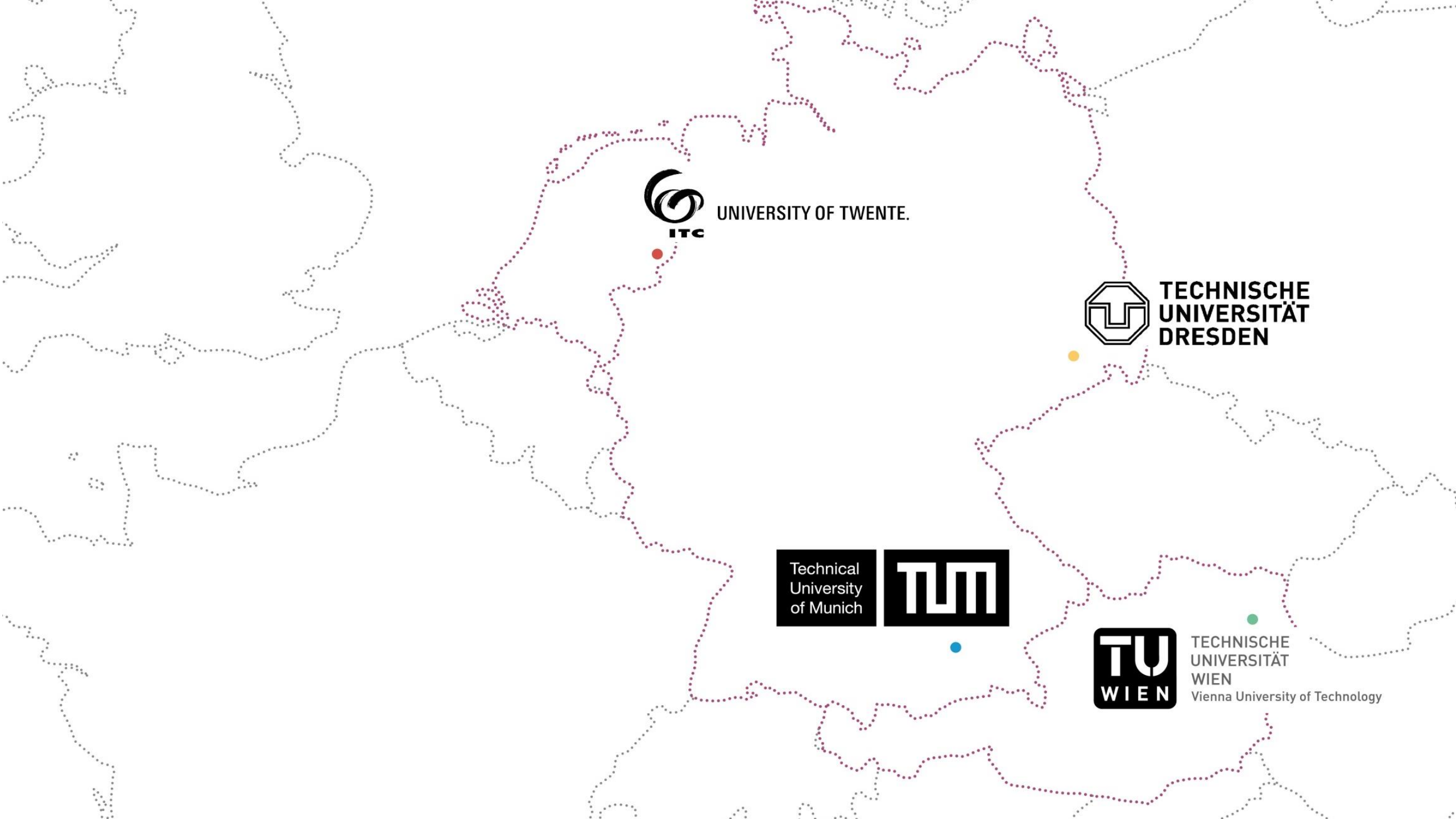
Through the visualization of textual description, **storytelling aims** to represent **landscape change** in action **through time** and to draw attention to the participant.

Multimedia is the key element of interactive storytelling.

The implementation of this idea in another city would be the determination of the smallest scale so that the space is larger and the presentation of the elements would happen more often.
Frequent animation presentations would make storytelling more realistic and more emotional.

- Different scale,
- Adding more 3D models,
- Evaluation with further participants.

Thank you for your time.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UNIVERSITY OF TWENTE.
TECHNISCHE
UNIVERSITÄT
DRESDEN
Technical
University
of Munich
TU
WIEN
TECHNISCHE
UNIVERSITÄT
WIEN
Vienna University of Technology